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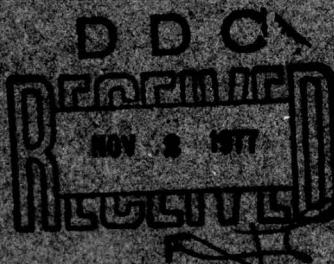
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DEVELOPMENT OF AN ULTRA HIGH LEVEL AIRCRAFT
CONTAINER CONCEPT

Paxac, Inc.

1910 Forest Drive

Anneapolis, Maryland 21401



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A Study was undertaken to determine the form and aerodynamic characteristics of an airdrop container capable of achieving a specified accuracy when dropped from ultra-high levels. This study resulted in a final design for a "semi-streamline aeroshell" which was shown to meet the limited technical criteria on which the program was based. During the program, half-scale models were dropped from helicopters at Natick, and wind-tunnel tested in the University of Maryland Glenn L. Martin Wind Tunnel. A six-degree-of		

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20. Abstract (continued)

freedom trajectory program was assembled and proven. It is now available for a statistical analysis of delivery accuracy. ←

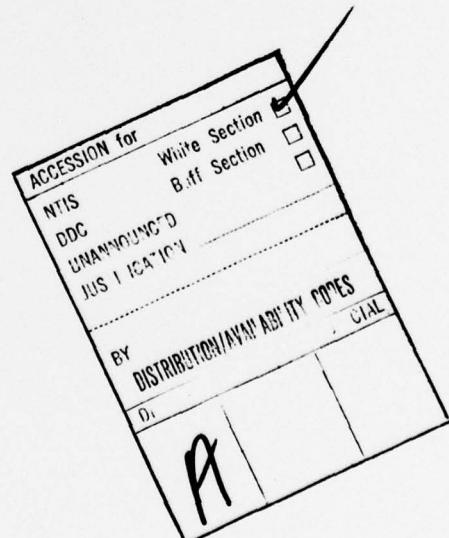
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PREFACE

This program was conducted by Payne, Inc., Annapolis, Maryland, for the US Army Natick Research and Development Command, formerly the US Army Natick Laboratories, Natick, Massachusetts, under Contract DAAK03-74-C-0197. The purpose of the program was to identify feasible approaches for achieving the capability of airdropping container loads weighing up to 220 lbs from high levels and landing them with a high degree of single-drop accuracy and minimum multiple-drop dispersion. The study resulted in a final design for a "semi-streamline aeroshell" which was shown to meet the limited technical criteria on which the program was based. During the program, half-scale models were dropped from helicopters at Natick, and wind-tunnel tested in the University of Maryland Glenn L. Martin Wind Tunnel. A six-degree-of-freedom trajectory program was assembled and proven. It is now available for a statistical analysis of delivery accuracy.

The program was performed under the direction of George Barnard, Project Officer, of the Aero-Mechanical Engineering Laboratory, Natick Research and Development Command. The project was managed at Payne, Inc. by P. R. Payne. The principal investigators and contributors were H. L. Newhouse, F. W. Hawker, and A. J. Euler.



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DEVELOPMENT OF AN ULTRA-HIGH-LEVEL AIRDROP CONTAINER CONCEPT

INTRODUCTION

Improved mobile surface-to-air missiles have made it necessary to consider drop altitudes up to 25,000 feet for resupply of isolated military positions. One proposed solution is to permit dropped cargo to fall ballistically until close to the ground, then deploy the recovery parachutes. To achieve this with the desired degree of accuracy from high altitudes, it is necessary to increase the terminal velocity of the cargo packages and to provide them with low drag stabilizing features. This approach is embodied in the Ultra High Level Container Airdrop System (UHLCADS).

By making a streamline container which has the same ballistic coefficient as a bomb, one can clearly achieve conventional bombing accuracy down to the altitude for parachute deployment. But of course, the usable volume of such a container would be low in relation to its outside dimensions, the cost would be high, and the quantity of payload per drop severely restricted.

Between the extremes of the irregularly square shape of the present A-22 container on the one hand, and a streamline bomb shape on the other, there are many "semi-streamline" shapes which could be employed. And, of course, the ballistic coefficient can be reduced to a value compatible with actual cargo densities, at some cost in accuracy. The problem is to quantify these considerations, and develop a design which has "good enough" accuracy, yet is still affordable.

THE PAYNE PROGRAM

It was initially decided that the cargo must be contained inside an aerodynamic fairing - now called the "aero-shell" - and that this should deviate as little as possible from a square box shape, four feet on each side. Earlier work¹ had suggested that a terminal velocity of 415 ft/sec would be adequate, implying a drag coefficient of about 0.45, a 55% reduction from that of the present A-22 container when unstabilized. Previous experience² led us to believe that fairly modest radiusing of the forward facing edges of such a box shape would enable such a drag reduction to be achieved. The aero-shell would also need to be aerodynamically stabilized, of course, and because the cargo loading can never be perfectly symmetrical, the stabilizing fins need to impart a spinning motion to the vehicle, about the axis of flight, so that lateral aerodynamic forces are "averaged out".

Our first design (Figure 1) had stabilizer vanes analogous to the feathers on a shuttlecock. A number of half-scale models were airdropped and found to be unsatisfactory because

- (a) the drag was too high
- (b) static stability was marginal
- (c) damping was apparently negligible.

Two subsequent wind tunnel investigations³ revealed the reasons for these defects, and after a number of permutations, the configuration of Figures 2 and 3 was arrived at. The drag coefficient was found to be lower than the target figure (0.36 compared to 0.45) and stability was adequate.

A design for a practical aero-shell was then prepared,⁴ illustrated in Figures 4 and 5 and in the Appendix.

In parallel with this effort, a six-degree-of-freedom trajectory program was developed⁵ so that the effects of various asymmetries on trajectory could be computed. A limited number of such studies were successfully carried out, but many more would be needed to completely characterize the system, and contract funds were unfortunately insufficient to permit this.

¹ Farinacci, A.L., and Brunner, D.B., "High Level Container Airdrop System." US Army Natick Laboratories TR 73-55-AD, March 1973, AD 766-309.

² Payne, P.R., "On the Resistance of Blunt Forms." Journal of Aircraft, Vol. 3, No. 6, November-December 1966.

³ Hawker, F. W., "Determination of Optimum Aerodynamic Shape for the Ultra High Level Container Airdrop System." Phase II Final Report, Contract DAAK03-75-C-0197, Payne, Inc. Report No. 138-9, September 1975.

⁴ Newhouse, H. L., "Preliminary Design of an Integrated Cargo Container/Stabilizer, UHLCADS." Phase I Final Report, Contract DAAK03-74-C-0197, Payne, Inc. Report No. 138-8, September 1975.

⁵ Barlow, J.B., "A Six-Degree-of-Freedom Trajectory Program for the Ultra High Level Container Airdrop System." Phase III Final Report, Contract DAAK03-74-C-0197, Payne, Inc. Report No. 138-10, September 1975.

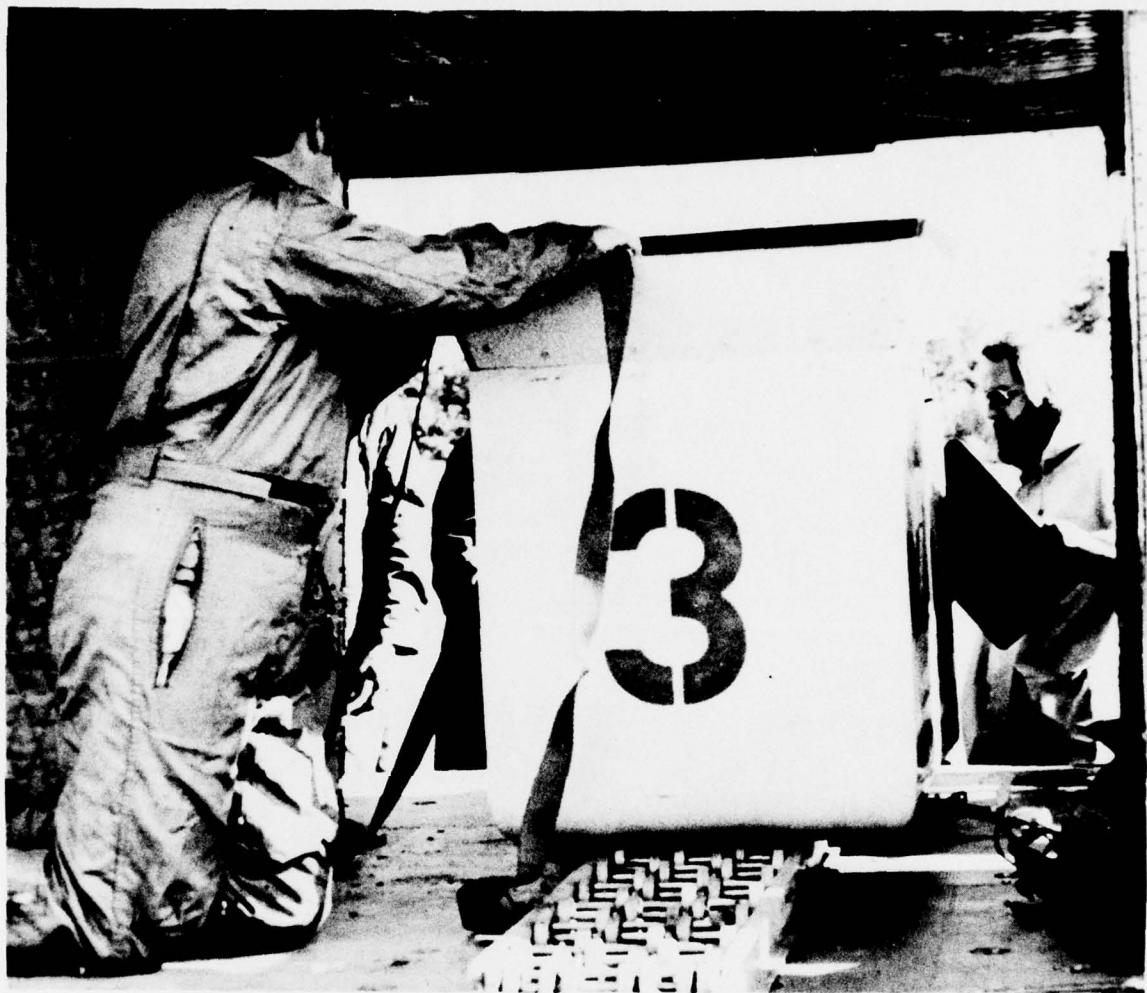


Figure 1. The first Payne aero-shell design for UHLCADS, shown here as a half-scale model built for air drop testing.

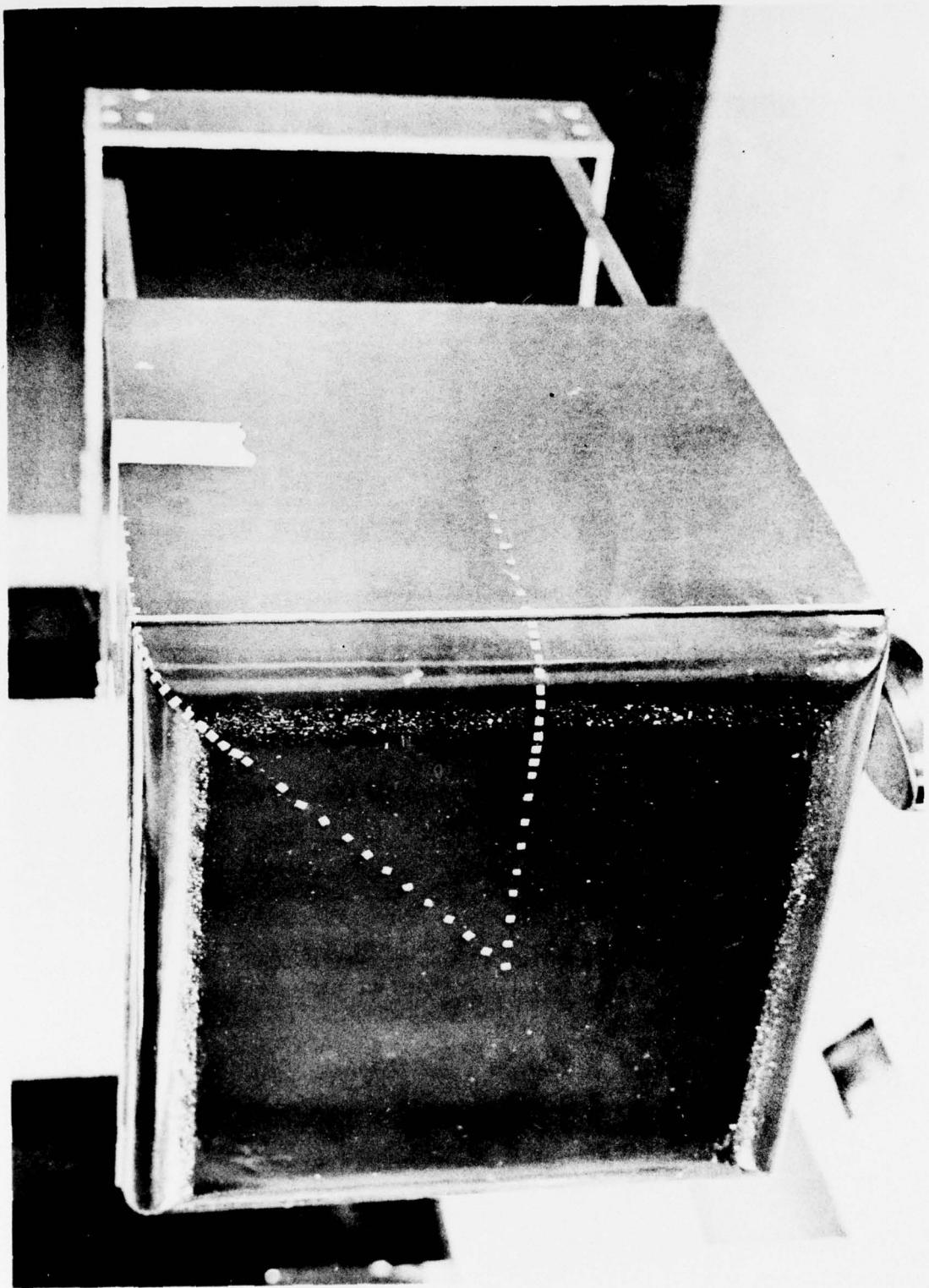


Figure 2. The final configuration, shown here as a half-scale wind tunnel model with pressure taps.

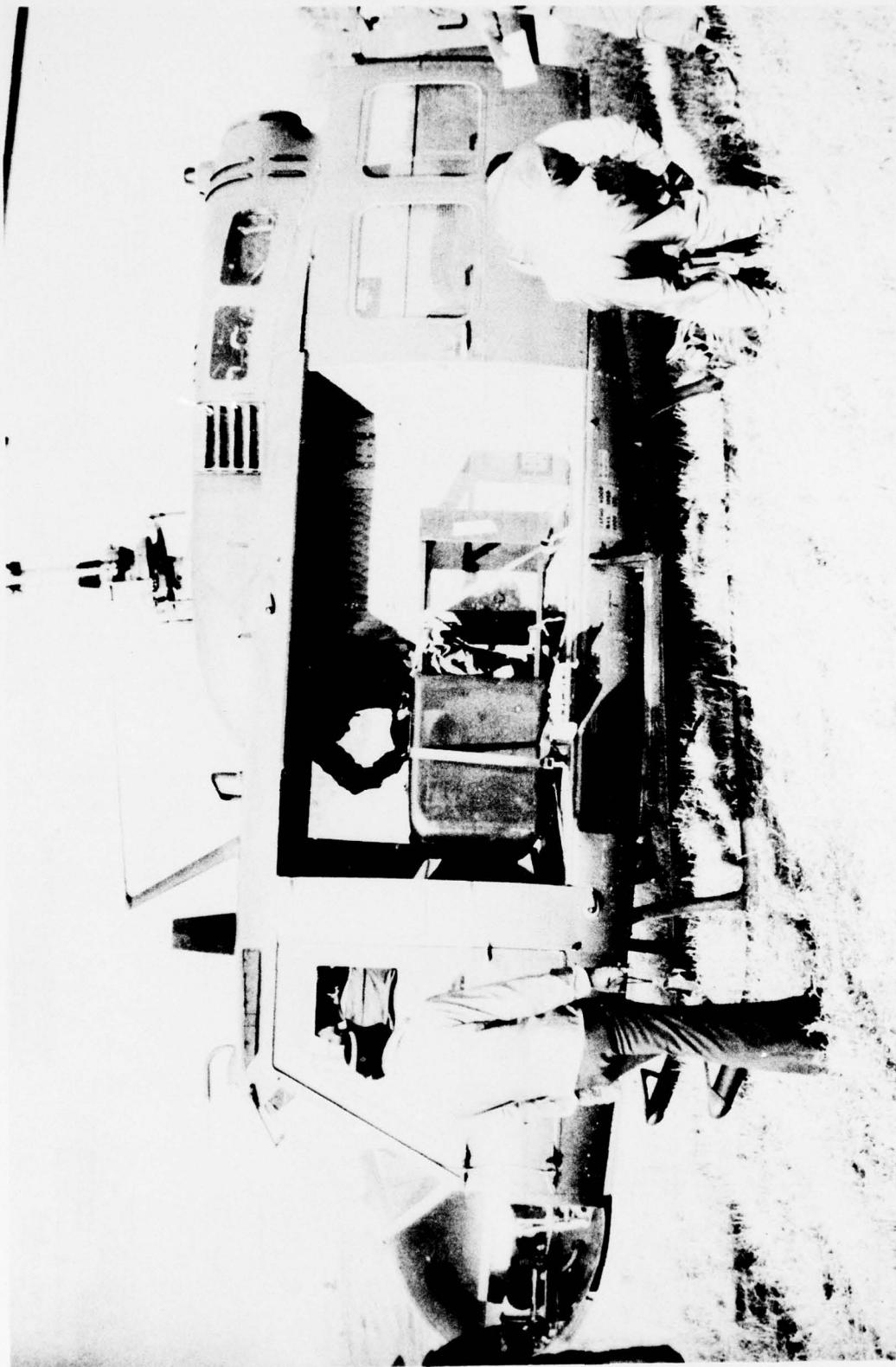


Figure 3. The final configuration as a half-scale model for air-drop testing.

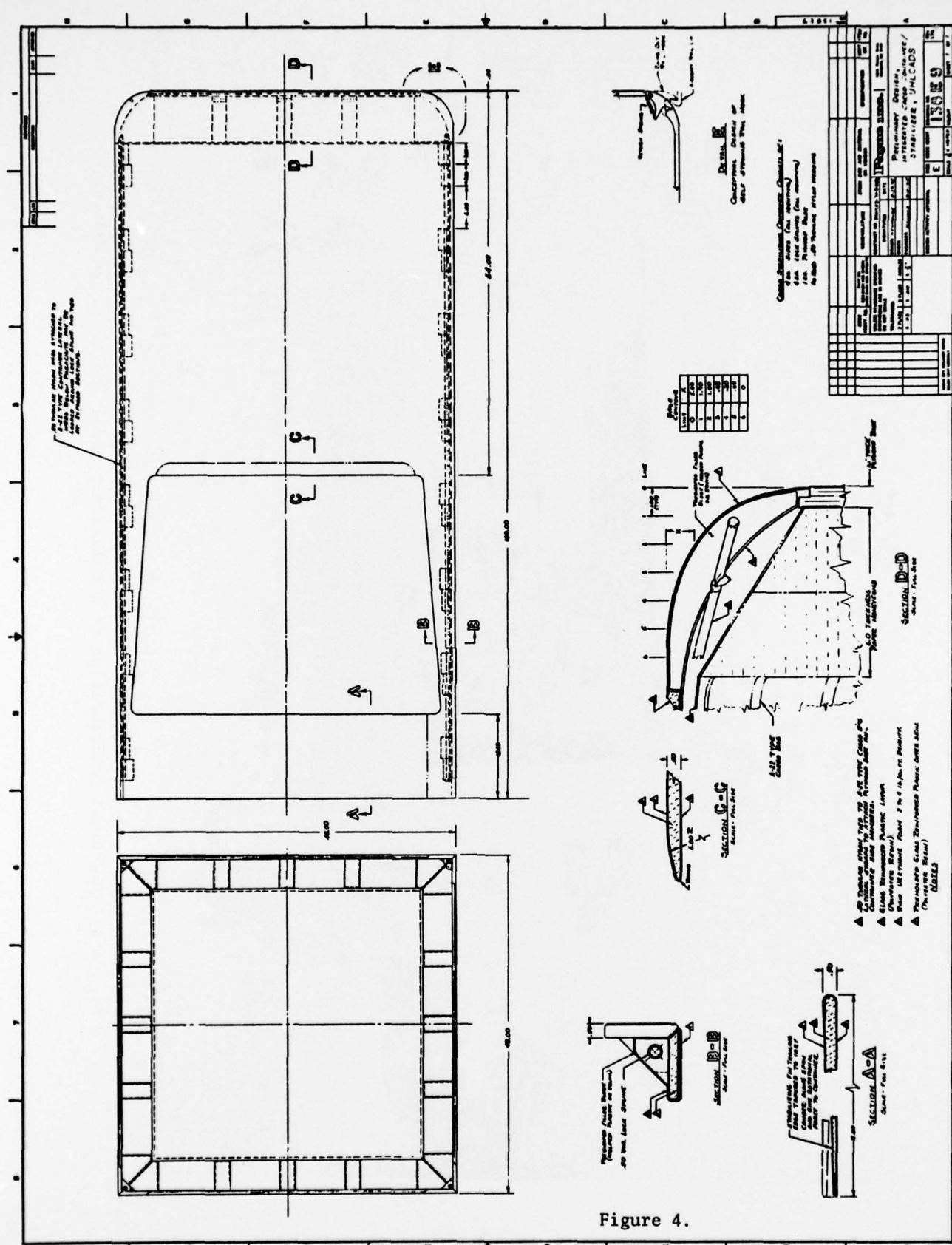


Figure 4.

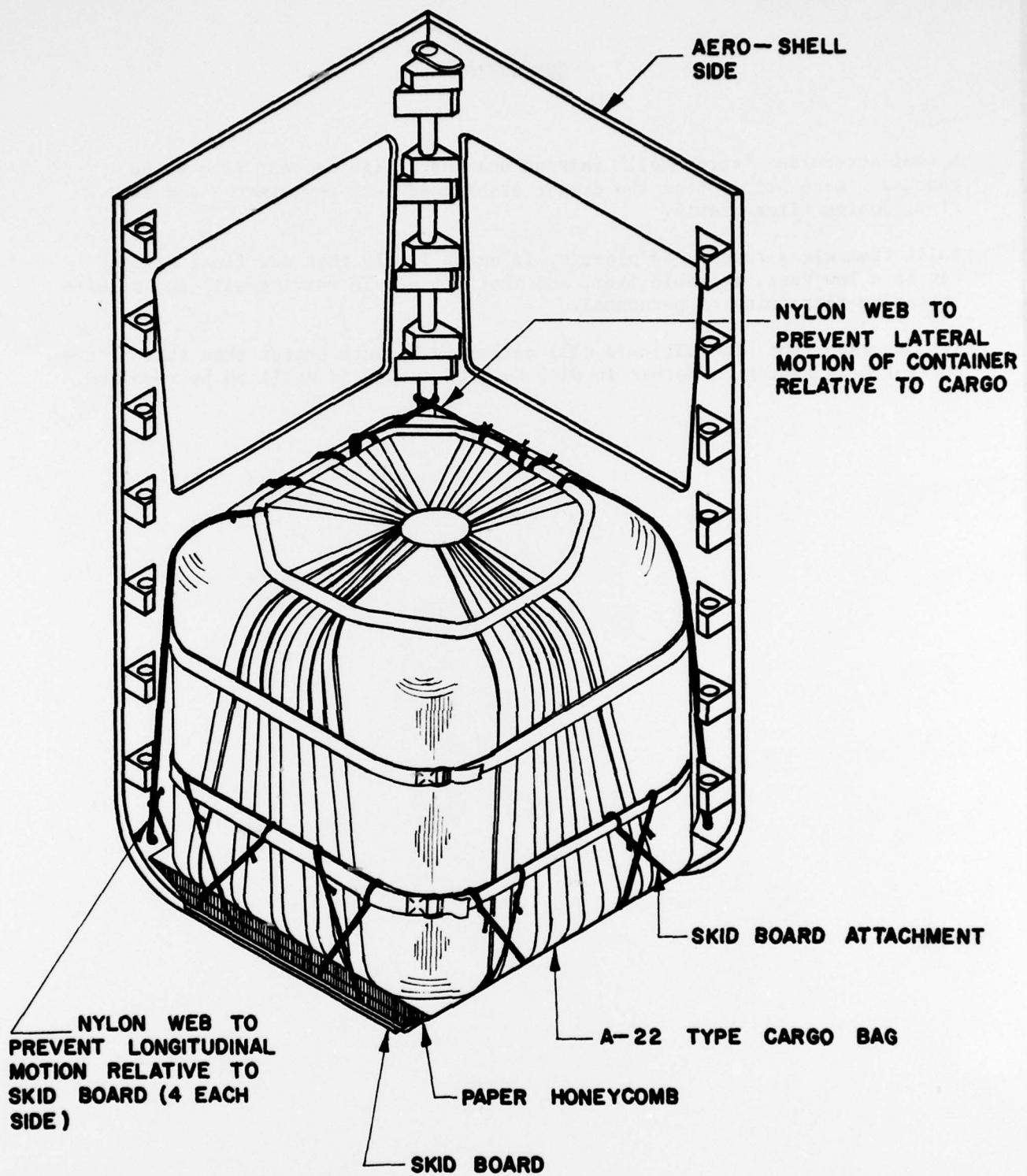


Figure 5. Schematic showing proposed aero-shell retention to the A-22 type cargo bag.

CONCLUSIONS

A semi-streamline "aero-shell" fairing enables a high descent rate to be reached - much higher than the drogue stabilized A-22 container - and the final design flies stably.

Built from glass-reinforced plastic, it seems likely that our final design can be a low cost, reusable item, and that its use in service will not require extensive retraining of personnel.

Its accuracy from high altitude will certainly be much better than that of the current A-22 system. Whether it will be good enough is still to be resolved.

REFERENCES

1. Farinacci, A.L., and Brunner, D. B. "High Level Container Airdrop System," U.S. Army Natick Laboratories TR 73-55-AD, March 1973, AD 766-309.
2. Payne, P.R. "On the Resistance of Blunt Forms," Journal of Aircraft, Vol. 3, No. 6, November - December 1966.
3. Hawker, F.W. "Determination of Optimum Aerodynamic Shape for the Ultra High Level Container Airdrop System," Phase II Final Report, Contract DAAK03-75-C-0197, Payne, Inc. Report No. 138-9, September 1975.
4. Newhouse, H.L. "Preliminary Design of an Integrated Cargo Container/Stabilizer, UHLCADS." Phase I Final Report, Contract DAAK03-74-C-0197, Payne, Inc. Report No. 138-8, September 1975
5. Barlow, J.B. "A Six-Degree-of-Freedom Trajectory Program for the Ultra High Level Container Airdrop System." Phase III Final Report, Contract DAAK03-74-C-0197, Payne, Inc. Report No. 138-10, September 1975.

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APPENDIX A

SEQUENTIAL ASSEMBLY OF THE
PAYNE UHLCADS AERO-SHELL

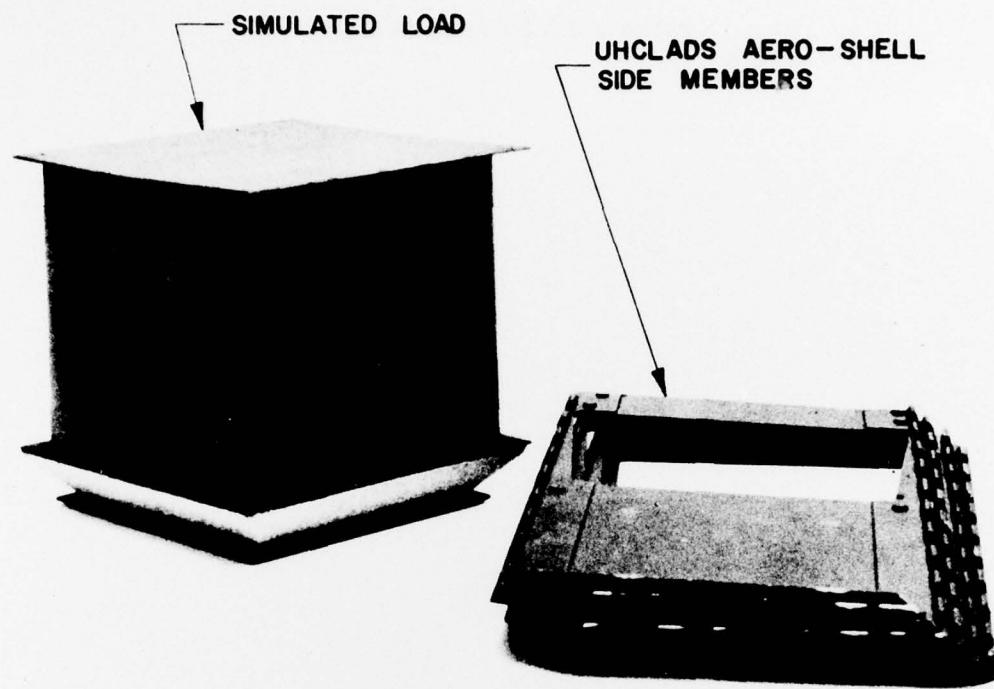


Figure I-1. Simulated load as built up and the UHLCADS aero-shell side members as removed from their shipping container.



Figure I-2. Two side members showing the interlocking corner joint detail.

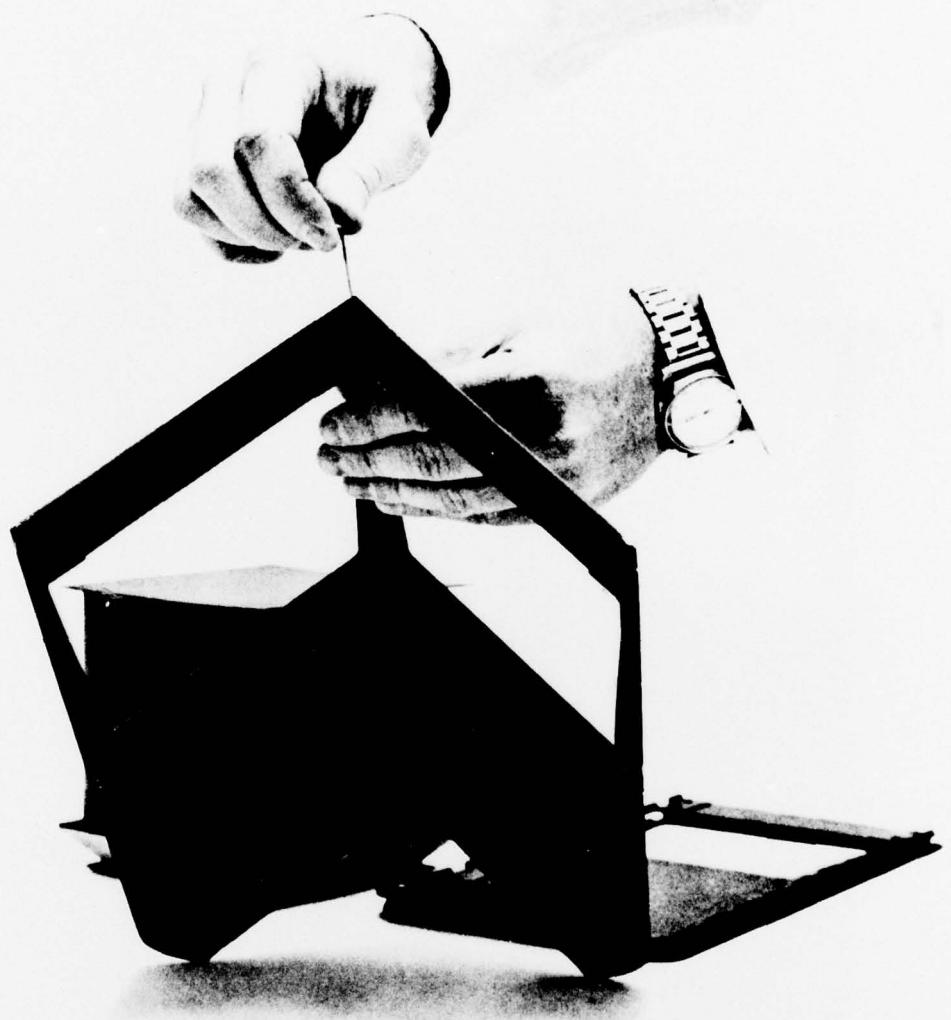


Figure I-3. Two side members being joined by the locking spline.

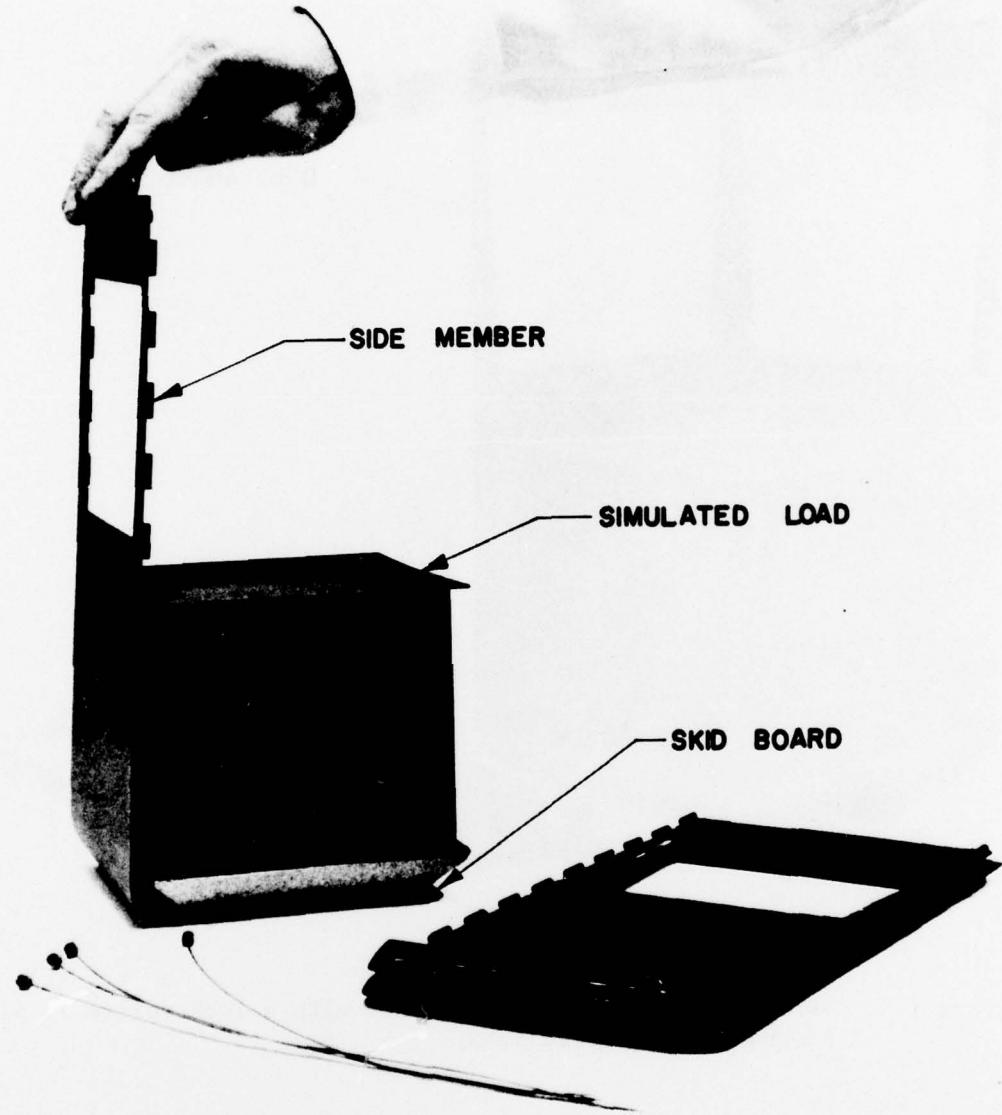


Figure I-4. A side member in position around the simulated load with the lower edge engaged in the skid board corner cutout.

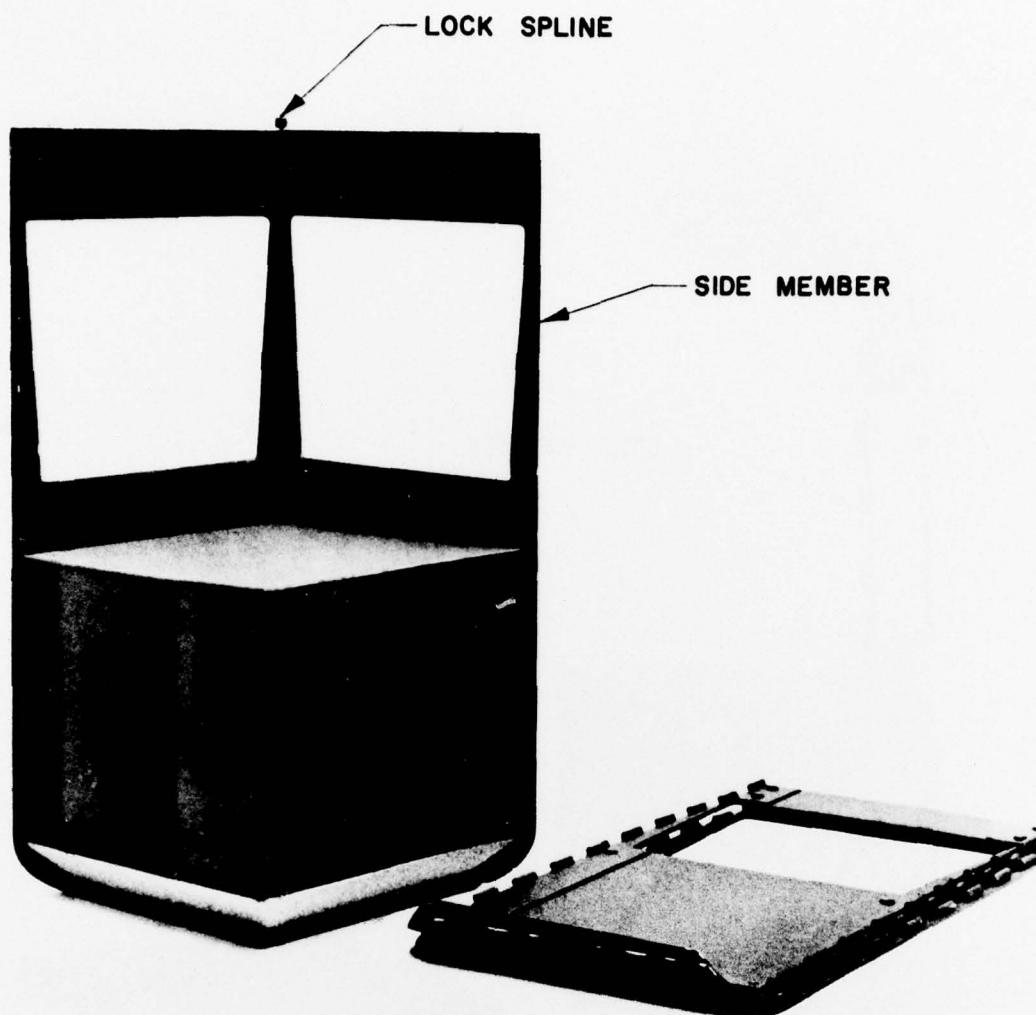


Figure I-5. Two side members locked together with a lock spline in place around the simulated load.

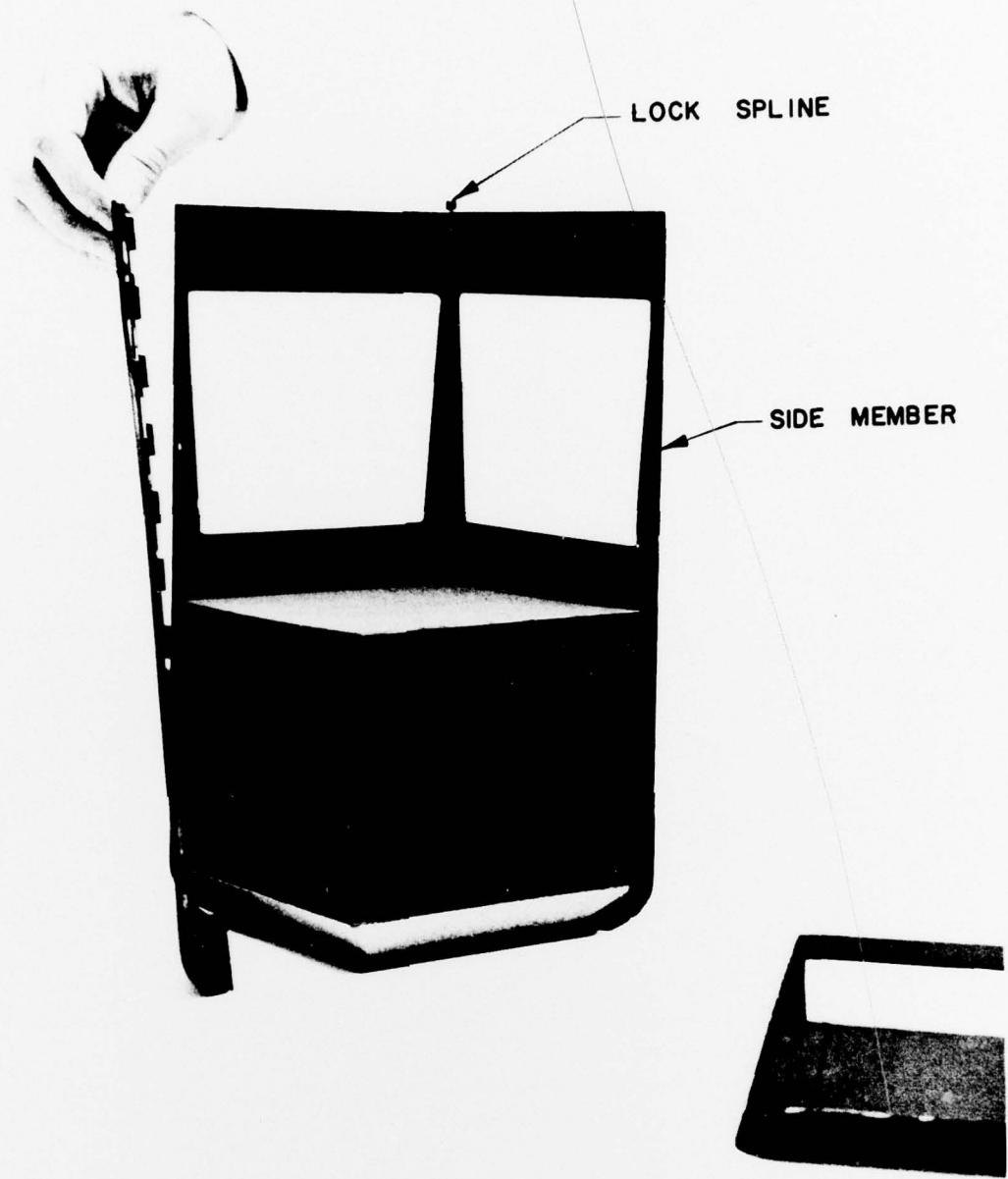


Figure I-6. Third side member being positioned around the simulated load.

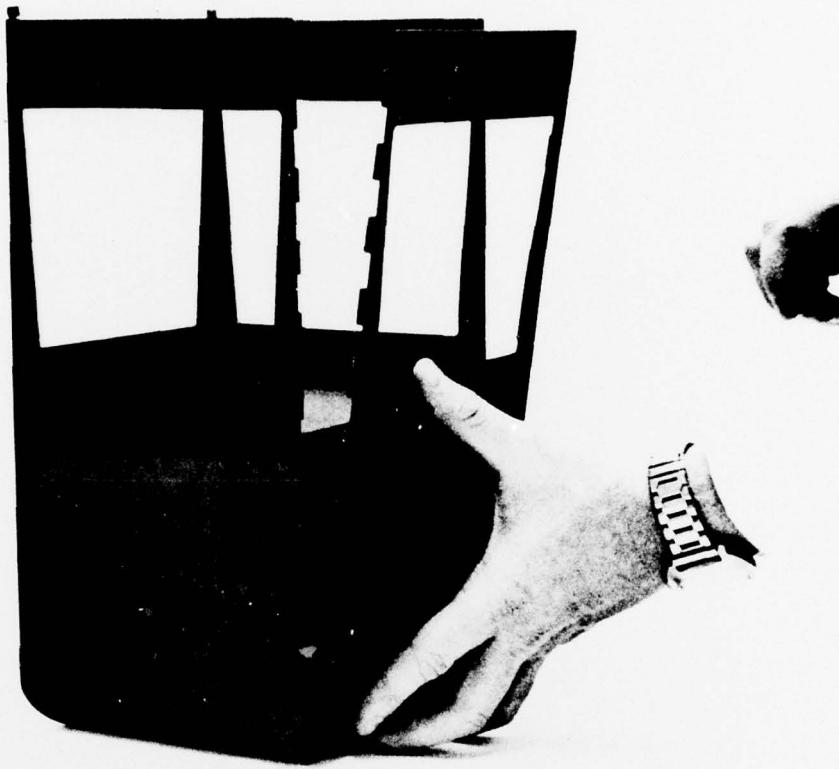


Figure I-7. Fourth side member being moved into position.

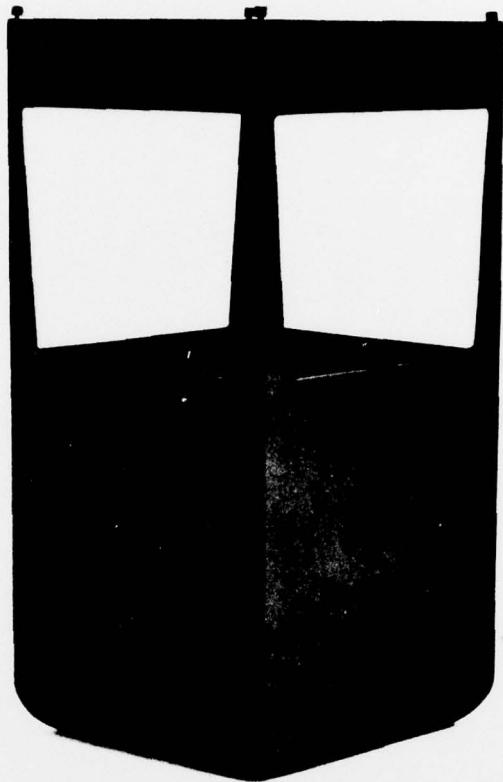


Figure I-8. Completed assembly of UHLCADS aero-shell.